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REPORT ON THE FOURTH UNITED NATIONS/EUROPEAN SPACE AGENCY WORKSHOP ON BASIC SPACE SCIENCE, HOSTED BY THE GOVERNMENT OF EGYPT

(Cairo, Egypt, 27 June-1 July 1994)

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INTRODUCTION

A. Background and objectives

1. The General Assembly, at its thirty-seventh session, adopted resolution 37/90 of 10 December 1982, endorsing the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) that the United Nations Programme on Space Applications should promote the growth of indigenous nuclei and an autonomous technological base in space technology in developing countries. At its thirty-sixth session, in June 1993, the Committee on the Peaceful Uses of Outer Space endorsed the United Nations Programme on Space Applications for 1994 as recommended by the Scientific and Technical Subcommittee of the Committee at its thirtieth session. Subsequently, the General Assembly, in resolution 48/39, endorsed the activities of the Programme on Space Applications for 1994.

2. The Fourth United Nations/European Space Agency Workshop on Basic Space Science was part of the 1994 activities of the Programme on Space Applications. The Workshop was co-sponsored by the Austrian Space Agency (ASA), European Space Agency (ESA), German Space Agency (DARA), International Centre for Theoretical Physics (ICTP), National Aeronautics and Space Administration of the United States of America (NASA), and The Planetary Society (TPS), and hosted by the Government of Egypt through its Ministry of Scientific Research, from 27 June to 1 July 1994.

3. The objective of the Workshop was to strengthen basic space science in developing countries by addressing the ways and mechanisms through which the following goals could be accomplished:

(a) To improve the awareness of scientists of current and future scientific and technical aspects of basic space science;

(b) To enhance scientific cooperation among developing countries;

(c) To explore avenues of education, training and research on basic space science subjects for the benefit of developing countries;

(d) To create an international core group of scientists to pursue the objectives of the Workshop.

4. The present report, which covers the background, objectives and organization of the Workshop, as well as giving a summary of presentations (see annex I to the present report), observations and recommendations made at the Workshop, has been prepared for the United Nations Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. Participants in the Workshop will report to appropriate authorities of the Government, universities and research institutes in their respective countries.

B. Organization and programme of the Workshop

5. Invitations to participate in the Workshop were sent by the United Nations to scientific professionals with substantial experience in one or more of the following areas; (a) international cooperation in basic space science; (b) databases and on-line data in astronomy; (c) present and future planetary missions; (d) comparative planetology: atmospheres and climate; (e) comparative planetology: surface processes; (f) the Sun; (g) cosmology; and (h) ground-based and space-based astronomical observations. The Workshop was attended by 95 scientists from 22 countries: Austria, Bahrain, Canada, China, Colombia, Costa Rica, Egypt, Germany, Honduras, India, Japan, Kenya, Mauritius, Mozambique, New Zealand, Nigeria, Oman, South Africa, Spain, United States of America, Zaire, Zambia; and

7 national and international organizations: the United Nations, ASA, DARA, ESA, ICTP, NASA and TPS.

6. Funds allocated by the United Nations, ASA, DARA, ESA, ICTP, NASA and TPS for the organization of the Workshop were used to cover the cost of international air travel and daily subsistence allowance for 28 participants from 15 countries. The Government of Egypt provided the Workshop facilities and local transportation for the duration of the Workshop, and room and board.

7. In Cairo, welcoming addresses were made by H.E. Prof. Dr. V. K. Gouda, Minister of State for Scientific Research, Egypt, on behalf of the Government of Egypt; Prof. Dr. M. Abdel Hady, Chairman, on behalf of the National Authority for Remote Sensing and Space Science, Egypt; Dr. N. Jasentuliyana, Director of the Office for Outer Space Affairs, on behalf of the United Nations; Dr. W. Wamsteker, ESA IUE Observatory Manager, on behalf of ESA; and Dr. A. Ocampo, Planetary Geologist, on behalf of TPS.

8. The scientific programme of the Workshop (see annex II to the present report) was developed by the United Nations Office for Outer Space Affairs, in collaboration with ESA, TPS and the Ministry of Scientific Research, Egypt. The Workshop included five days of plenary and working group sessions with presentations by invited speakers only. The Workshop sessions were held in an informal style, leaving enough time for informal discussions and a few *ad hoc* contributions from participants. The morning of Friday, 1 July, was exclusively reserved for Working Group sessions in which participants discussed in-depth the national capabilities to develop programmes and to undertake research activities in basic space science and ways to foster international collaboration in the field. The proceedings of the Workshop will be published in the international journal of cosmic physics Astrophysics and Space Science and the international journal of comparative planetology Earth, Moon, and Planets.

OBSERVATIONS AND RECOMMENDATIONS

A. Basic space science

9. In order to assist scientists in developing countries in finding the necessary support in the pursuit of basic space science, great efforts should be made to create awareness of the importance of basic space science for national development among decision makers and the general public. In reconsidering the suggestions contained in the reports of the first three United Nations/ESA Workshops on Basic Space Science, held in India, in 1991 (A/AC.105/489), in Costa Rica and Colombia, in 1992 (A/AC.105/530), and in Nigeria, in 1993 (A/AC.105/560/Add.1), participants noted that the goals associated with basic space science in West Asia are related to the desire to educate their own basic space scientists as well as the engineers, managers and technicians needed for self-reliant development and management of the resources of the continent through the tools and knowledge acquired in the pursuit of basic space science as defined by the following areas of research: (a) astronomy and astrophysics; (b) solar-terrestrial interaction and its influence on terrestrial climate; (c) planetary and atmospheric studies; and (d) origin of life and exobiology. The participants stressed that the pursuit of basic space science, even under the current difficult economic conditions, represents an important effort to maintain cultural values and at the same time stimulate the modernization of society. The fact that basic space science relates to subjects which extend beyond the geopolitical distribution of the world, assures that it also presents a very powerful means of fostering inter-regional collaboration.

10. Participants agreed that the following techniques would be applicable for pursuing basic space science research:

(a) Ground-based optical, infrared and radio observations and radio and optical telescopes with associated equipment;

(b) Remote sensing, both from the ground and from space;

(c) In situ measurements from rocket, balloon and satellite platforms;

(d) All measurements from ground-inaccessible windows (e.g. X-ray and others) which could be made only through the use of instruments and telescopes in Earth orbit;

(e) Phased radar techniques.

B. Availability and dissemination of scientific information

1. Access to information

11. Major space agencies of the world should be urged to supply advanced information regarding various projects to scientists in developing countries so that those scientists may involve themselves in follow-up studies.

12. Considering the very high price of scientific journals and the recognized disadvantage associated with the unavailability at a professional level of information on front-line research in all countries associated with the previous workshops, it is recommended that all research groups interested in basic space science should request assistance in contacting publishers with a view to investigating mechanisms that would enhance worldwide availability of such journals.

13. In view of the severe difficulties encountered by researchers in acquiring textbooks, conference proceedings and other materials needed for advanced scientific research, efforts should be made to ensure the printing, in association with activities already being carried out by the International Astronomical Union (IAU), ICTP, European Physical Society (EPS) and American Institute of Physics (AIP), of textbooks in English on basic space science at the elementary, primary, secondary and undergraduate levels, as well as popular texts on basic space science in that language. The participants felt that there is a strong need to create a wider awareness of the importance of basic space science in the general public. It was highlighted that such can only be accomplished through information distribution in the native language. It was recommended that the United Nations investigates avenues to promote the availability of existing information in ways more accessible to the general public.

2. Data archives and data centres

14. The participants emphasized the importance of the availability at the national level of existing basic space science data archives for building up first-rate educational and research capabilities for internationally recognized scientific investigations. The availability of some of those on a regional basis could be considered an important step in this direction, but a national centre for such data will greatly enhance its availability.

15. Member States were urged to select, through national discussion, local or regional clearing-houses for the highly valuable data archives that are still available at no cost from their producing agencies. The owners should be requested to deliver such data products in a manner conducive to easy dissemination and access at the national level, e.g. Cosmic Background Explorer (COBE) skymaps, Roentgen Satellite (ROSAT) survey data, International Ultraviolet Explorer (IUE), Uniform Low Dispersion Archive (ULDA) and Planetary Data System (PDS). Those clearing-houses (or data centres)

would foster the development of national basic space science resources and stimulate international collaboration by the existence of centres of common interest. They would also make highly valued data pertaining to individual countries more accessible to other countries, and consequently enhance awareness of the capabilities of each country.

16. Existing or planned centres are strongly recommended to open their facilities beyond national borders to support and stimulate regional access, which is considered to be mutually beneficial and will stimulate development at a regional level, making use also of the services of the Regional African Satellite Communication System (RASCOM).

3. Information management system

17. The participants noted that the United Nations had consulted with institutes and researchers concerning the availability of the above-mentioned information and the collection of detailed information on bilateral and multilateral arrangements allowing an exchange of students and researchers for learning as well as teaching purposes. A document containing that information was distributed at the meeting (A/AC.105/548).

18. Recognizing that a country's level of involvement in the activities in basic space science is invariably associated with existing economic conditions, the participants recommended the development of new initiatives in developing countries for deeper involvement in basic space science. They recognized, however, that such new initiatives should be accommodated within the existing individual infrastructure of the country. They also recognized the importance of exploring ways and means by which the evolution of individual countries' basic space science activities and international cooperation could be maintained and stimulated.

19. The participants noted with satisfaction the efforts already taking place in the region of Western Asia to enhance university curricula in basic space science and highlighted the importance of these curricula especially when established at the introductory level, even without incorporation of advanced degrees.

4. Electronic communication network

20. The participants reconfirmed the importance of the free flow of ideas and concepts for a strong participation in basic space science. The implementation of local (national) information and communication networks, as well as the internationally functioning INTERNET and similar activities are of fundamental importance for creating the infrastructure required to enhance and expand regional participation in basic space science.

21. It is especially desirable to realize the importance for the region of such connections, since this will more than any other investment stimulate regional development by communication between scientists with common interests, to address regionally associated problems with far higher efficiency.

22. Member States should identify requirements without which the above-mentioned facilities cannot be implemented and should identify and possibly provide the minimum necessary investment to start implementation.

5. Use of available scientific databases

23. The participants recognized the importance of access to advanced instrumentation and modern extended data sets for the evolution of basic space science disciplines and urged Member States and their

scientists to utilize those facilities that are currently available. Much of this could be accomplished by the utilization of existing available databases (such as those available for IUE and EXOSAT and that have now become available from the planetary missions), but additional direct use of these facilities would add critical impetus to the development of institutions unfamiliar with these facilities.

24. The distribution and acquisition of software, especially in relation to the techniques related to data acquisition, data reduction, image processing and physical modelling, which has already been developed, could save considerable investment.

25. The United Nations recognizes the importance of the international nature of the major basic space science facilities in Africa such as the South African Astronomical Observatory (SAAO) and the Hartebeesthoek Radio Astronomy Observatory (HARTRAO). It recognizes the opportunities offered on a regional basis for Africa and West Asia in basic space science. The United Nations recommends using the experience accumulated by these two Observatories to stimulate the development of basic space science in the region through the sharing of facilities.

C. Availability and establishment of scientific facilities

1. Utilization of infrastructural facilities

26. In order to stimulate the utilization of the existing major facilities in basic space science by scientists from developing countries and to enhance their awareness, countries possessing better facilities should be encouraged to open them to developing countries; and developing countries should seek short-term fellowships and travel grants for such purposes.

2. Utilization of ground-based facilities available in developing countries

27. Questions on basic space science require experimental verification beyond the resources of individual nations. Therefore, the development, on a regional basis, of locations in West Asia and Africa, whose climatic and geographical conditions offer unique opportunities for such work should be considered. On a global scale these should be considered for development and coordination with other organizations supplying similar facilities elsewhere in the world. International and interregional collaboration also offers unique opportunities also for the upgrading of existing facilities.

28. In order to help in the development of space science and technology in West Asia and Africa, relevant international organizations should support (a) the participation of West Asian and African technology in space science projects of the major space agencies; and (b) hardware development in West Asian and African countries for these projects.

D. International cooperation in basic space science

1. International cooperation and internationally coordinated basic space science programmes/projects

29. A regional directory of basic space scientists and institutions in West Asia and Africa should be published. Information on possible sources of funding for training and research support for the different countries should be collected and included in the directory.

30. The United Nations, recognizing that the benefits of the pursuit of basic space science investigations constitute a prime motive for collaboration between Member States, should therefore support and recommend:

(a) Further expansion and continuation of studies of the Equatorial Electrojet (EEJ) and the South Atlantic Geomagnetic Anomaly in the context of regional/international collaboration involving:

(i) Reactivating selected geomagnetic and ionospheric observatories, as well as enhancing support for the networks of such observatories;

(ii) Encouraging active scientists to participate in and to organize international meetings;

(iii) Creating national committees for the Committee on Space Research (COSPAR) for those Member States not already belonging to that organization, which is a major focal point for the coordination of studies in the field;

(b) Development and construction of optical telescopes and radio telescopes with observatory facilities by West Asian and African countries for use by the basic space scientists of the region;

(c) Augmentation of the global coverage of INTERMAGNET by the establishment of three observatories in Sri Lanka, eight in Africa and eight in Latin America and the Caribbean;

(d) Establishment of a regional information centre specifically oriented to astrophysics and atmospheric and planetary sciences for the purpose of:

(i) Disseminating all relevant data obtained under basic space science activities such as remote sensing, atmospheric probing, astrophysics and geophysics to provide vital regional information for addressing problems related to disaster management and warning;

(ii) Developing a new understanding of the globally important equatorial zone, and therefore developing a plan in the developing countries leading to improved resource management and improved living conditions;

(e) Strengthening and reorienting current research activities in the fields of solar-terrestrial, atmospheric and climatic studies, combined with space remote sensing observations and comparative planetary sciences with participation in The International Geosphere-Biosphere Programme (IGBP): A Study of Global Change and associated programmes such as the Global Change System for Analysis, Research and Training (START), including:

(i) Satellite observations to assess pollutant-rich areas;

(ii) Ground and air truth measurements of solar radiation related to a variety of minor constituents;

(iii) Physical understanding and mathematical modelling of the interlinked processes of global change;

(f) Strengthening current research activities in the fields of astronomy and astrophysics, including:

(i) Experimental, observational and theoretical astrophysics;

(ii) Participation of West Asian and African astrophysicists in worldwide programmes supported by IAU;

(iii) Systematic galactic and extragalactic observations from equatorial latitudes in the southern hemisphere over the entire electromagnetic spectrum;

(g) Further development of the Kottamia Observatory, to assure that the importance of this telescope facility, which represents the major telescope in Western Asia, should be realized. The importance of this facility, which would supply major experimental capabilities for basic space science in the region, is enormous. The participants noted with great satisfaction that willingness to cooperate in this effort, exists and stressed that a collaborative effort to bring about the modernization of the Kottamia Observatory represents one of the most important efforts in West Asia and recommends that this should be done with the highest urgency. The intention to open the Kottamia Observatory for access to all scientists from the region presents very important experimental opportunities for basic space science. The plans of scientists from other countries, both in Western Asia and Africa, to share in the further development of the Kottamia Observatory will contribute much to the future development of basic space science in these regions and will enhance in a significant manner the opportunities for all basic space scientists in these regions, especially for studies in astronomy;

(h) The participation of scientists in developing countries in the campaigns associated with the Whole Earth Telescope (WHET) activities. This represents a strong and efficient mechanism to foster collaboration between scientists in the developing and developed countries. These will in an effective way promote:

(i) Basic space science research and education in the participating countries;

(ii) Expansion of networks, thus allowing a more efficient flow of scientific information;

(iii) Development of existing facilities in developing countries.

31. The participants recognized the difficulties existing in smaller developing countries relating to maintaining and participating in the technological and social developments following naturally from a viable programme in basic space science. They also recognized the problems associated with the relative isolation in which scientists pursue their efforts in those cases. International organizations should therefore support:

(a) The organization of regional connectivity through data networks;

(b) The stimulation of institutional relations between those regional centres of expertise and local institutes to allow the build-up of a national capability to participate in the rapid scientific, technical and associated cultural development in the world;

(c) The training and further development of human resources, to stimulate and enhance the participation, in a balanced development, even of smaller countries;

(d) The active stimulation of students in basic space science by participation in exchange programmes on a regional basis, as well as the exchange of prominent teachers and high-level technicians on a regional basis;

(e) Efforts to create awareness of the importance of basic space science for both decision makers and the general public.

2. Meetings and symposia on basic space science

32. Considering the growing interest and contribution made by several developing countries in basic space science and the need for further encouraging such activities, the United Nations should organize and support international meetings, for in-depth discussions on specific topics of basic space science.

3. Continuation of the Workshop on Basic Space Science

33. In order to assure a continued and coordinated evolution of the important issues raised in the current and the previous workshops, it was proposed to hold future basic space science workshops annually, although in the long run they should be held no more than biennially.

34. The United Nations should inquire into the possibilities of a country hosting the next Basic Space Science Workshop in 1996.

4. Space education

35. Considering that basic space science is not taught at higher levels in many developing countries, relevant international organizations should act to encourage and support:

(a) The introduction of the teaching of basic space science, including experimental techniques, as a part of the curriculum for primary and secondary level education as well as undergraduate and graduate education, by the implementation of basic space science curricula at universities and technical schools;

(b) Formation of research facilities at universities so that motivated students may be encouraged to pursue basic space science research;

(c) Organization of summer schools and other similar orientation programmes to train existing faculty in the physical sciences necessary to teach basic space science;

(d) Exchange of teachers, scientists and students to make use of the facilities in Member States and of the services of organizations such as IAU and COSPAR;

(e) Organization of seminars, workshops and topical conferences within the developing countries for the benefit of teachers, scientists, students and the general public;

(f) Introduction of popular programmes to encourage and support awareness of basic space science, and the coordination of such activities between Member States;

(g) Establishment of programmes ensuring the availability of basic textbooks and more popular information media at the professional and general public levels;

(h) Distribution and acquisition of educational software for basic space science;

(i) Generation of national career opportunities for professionals trained under the above-mentioned programmes, leading to the increased competitiveness of developing countries in the peaceful study and utilization of resources associated with basic space science;

(j) Strengthening of the IAU visiting lecturer programme, in coordination with IAU, with special emphasis on West Asia and Africa;

(k) Organization, under the auspices of IAU, of two consecutive, annual, regional African summer schools for teachers in the application of experimental techniques.

5. International core group

36. In order to pursue and follow up the recommendations made during the Workshop, it was decided to constitute a core group, under the auspices of the United Nations (Office for Outer Space Affairs), of international scientists consisting of the following members at the functional and advisory levels:

Functional members: Selection of a group of five members in good standing from the basic space science community and one member from the Office for Outer Space Affairs of the United Nations;

Advisory members: COSPAR, ESA, IAU, ICTP, Institute for Space and Astronautical Science (ISAS), NASA, TPS and two members from the region of the next Workshop.

37. The creation of the international core group is considered critical to maintaining the impetus generated by the first four workshops on basic space science for developing countries, and will assure the continuity of this important activity.

38. Core group activities are as follows:

(a) To review the status of basic space science developments in the region during the Workshop;

(b) To assure that the regional benefits of the Workshop are optimized through the selection of the programme;

(c) To maintain the purely scientific nature of the Workshop.

39. Recognizing the on-going efforts of the Programme on Space Applications to establish regional centres for space science and technology education, the Workshop urges all West Asian and African States Members of the United Nations to give maximum support to this initiative of the United Nations.

Annex I

SUMMARY OF PRESENTATIONS

A. International cooperation in basic space science

Space science in Western Asia

1. Knowledge of astronomy is at the root of human civilization. But very few students opt for the subject in the university because of limited employment prospects. In this presentation an attempt has been made to show that a modern broad based astronomy syllabus should make astronomy graduates as employable as students of physics and mathematics. However, astronomy will best be taught in the physics or mathematics department, up to B.S. level. A higher level course will be difficult to sustain in most countries. A concept of globalized education has been introduced for professional education including astronomy. A suitable public relation activity has been proposed. Establishment of an observatory is costly but the problem can be ably addressed through cooperation between existing observation programmes.

B. Databases and on-line data in astronomy

Utilization of the European Hubble Space Telescope Science Data Archive

2. The European Hubble Space Telescope (HST) Science Data Archive has been established at the Space Telescope European Coordinating Facility, located at the European Southern Observatory in Garching, Germany. An overview of the design and implementation of the system was presented. The system is fully accessible through wide area computer networks, such that researchers in remote locations can access the data from their computers. A number of utilization scenarios were given.

Cosmic Background Explorer (COBE) database and how to use it

3. Some of the mission data of COBE has been released by NSSDC, and it is available to the international scientific community. These data are relatively new and their analysis has a great potential for important contributions in the development of cosmology. Using these data for the first time, however, is not straightforward. Understanding the data, their format and limitations is obviously a necessary step before any scientific analysis may be done. An introduction to the COBE-DMR dataset was presented. The skycube database scheme used by COBE was discussed and examples of algorithms to use these data were given.

On the use of COBE results

4. An expression for the influence of the gravitational field of the spatially perturbed Friedmann-Robertson-Walker expanding Universe (FRW) on the time variation of the magnitude of the angular gradient of the intensity of the cosmic microwave background radiation (CMBR) was obtained. It has been shown that this influence is manifested via the square root of the angular spatial perturbation in the gravitational potential. Moreover, it has been shown that using this study and COBE results, it is possible to find out the lower limit for the initial angular gradient of the intensity of CMBR.

C. Present and future planetary missions

Sun, Earth and sky

5. The Sun is enveloped by a hot, tenuous million-degree corona that expands to create an eternal solar wind that sweeps past all the planets and fills the heliosphere. The continuous solar wind is modulated by strong gusts that are initiated by powerful explosions on the Sun, including solar flares and coronal mass ejections. This dynamic, invisible outer atmosphere of the Sun is currently under observation with the soft X-ray telescope aboard the Yohkoh spacecraft, whose results were summarized. Results were also presented from the Ulysses spacecraft that is now passing over the solar pole, sampling the solar wind in this region for the first time. The terrestrial magnetic field hollows out a protective, magnetic cavity, called the magnetosphere, within the solar wind. This protection is incomplete, however, so the Sun feeds an unseen world of high-speed particles and magnetic fields that encircle the Earth in space. These particles endanger spacecraft and astronauts, and also produce geomagnetic storms and terrestrial auroras. An international flotilla of spacecraft is now sampling the weak points in this magnetic defence. Similar spacecraft have also discovered a new radiation belt, in addition to the familiar Van Allen belts, except fed by interstellar ions instead of electrons and protons from the Sun. Two other spacecraft, Voyager 1 and 2, have recently detected the outer edge of the invisible heliosphere, roughly halfway to the nearest star.

Design and navigation of space missions

6. This presentation first described the mission design process at high level. The iterative nature of this process was emphasized and mission design detail and mission analysis were discussed. Finally as part of mission operations, space navigation was addressed.

Galileo mission

7. The Galileo spacecraft was launched in 1989 and will arrive at its destination, the Jupiter system, in December of 1995. The objective of the mission is to study the planet Jupiter, its satellites, and the Jovian magnetosphere and plasma environment. Galileo's trajectory has taken it to Venus and to the asteroids Gaspra and Ida. On its journey, Galileo flew by the Earth-Moon system twice. The reason for the trajectory was to obtain gravity assists from the Earth and Venus. Galileo carries a complement of instruments including the Near Infrared Mapping Spectrometer, the first instrument of its kind to be flown in a planetary mission. This lecture discussed the mission objectives, the results obtained so far (including the discovery of the asteroid Ida's moon), as well as the plans for observing the Galilean satellites.

The Discovery programme

8. A new era of space exploration has begun where missions must reach their target quickly and be low cost. This challenge is the core of the Discovery programme. The Discovery programme seeks to expand human knowledge of the solar system, with an emphasis on planetary systems. The programme is managed by the Solar System Exploration Division of NASA. The enhancement of opportunity requesting submission of proposal is projected to come out in July 1994, with a deadline of September 1994. Announcement of selection will be made in January 1995. All missions proposed must not exceed US$ 150 million, including mission design, development and operation. Launch vehicles must be a Delta-II class or smaller if supplied by NASA. Launch vehicles, launch services, scientific instruments and spacecrafts may be contributed by international partners. Missions must be launched by 31 August 1999. Later launch dates should be proposed for subsequent announcements of opportunity.

Differential radial velocity spectrometer for extra solar planetary studies

9. Several problems make it difficult to study extrasolar planets. The angular separation between the star and its planet is very small (0.1 arcsec at 10 parsecs). The star is much brighter than its planet (stellar/planetary flux ratios of 0.1 to a 1000 million). Hybrid coronographs with apodized masks could reduce this dynamic range by a factor greater than 1000 by spatial filtering. Earth's atmosphere does not permit the nulling by interferometric techniques that could eventually be available with space based interferometers. The frequency domain may be used for additional nulling of the stellar flux. Due to differences in radial velocities towards the observer, the Doppler shift of the spectra of a star and its planet are not the same. These could in principle be measured separately against the observatory standard and necessary calculated corrections could then be applied. However the Differential Radial Velocity Spectrometer (DRVS) design envisages the use of the continuously monitored stellar spectrum itself as a dynamic reference against which the additional Doppler shift of the planetary spectrum is evaluated. This permits a better definition of the projected search space for the sought after planetary spectral line. The DRVS would essentially be a heterodyne spectrometer with suitably narrow filters to examine the planetary line windows in detail. Lasers tracking selected stellar spectral lines will be used as local oscillators for the DRVS receiver. If possible, several planetary spectral line windows should be searched to increase the available energy for detection. Correlations/code gain techniques could provide dramatic improvements in signal-to-noise ratios.

North-south asymmetry of the daily interplanetary magnetic field spiral

10. Interplanetary magnetic field (IMF) data recorded by Earth-orbiting spacecraft near 1AU (Astronomical Unit) during the period 1964-1990 have been analysed. This period covers solar activity cycles 20, 21 and the first half of cycle 22. The analysis reveals that: (a) the spiral angel north of the current sheet is higher than south of it; (b) during both negative solar polarity epochs the IMF spiral is stable near 45 degrees, while in the positive polarity epoch it shows more variation; (c) the included angle is lower than 180 degrees during years of negative polarity epochs and higher than 180 degrees during the positive polarity epoch; and (d) the Earth spent more time north of the current sheet during the period of anlaysis.

D. Comparative planetology: Atmospheres and climate

Observation of Pluto and Charon with the Hubble Space Telescope

11. Four exposures of the outermost known planet of our Solar System, Pluto, and its moon Charon were obtained with the Faint Object Camera of the Hubble Space Telescope after the First Hubble Space Telescope Servicing mission. The quality of the images, taken in the ultraviolet and visible wavelength range, is excellent, already demonstrating the superior capabilities of the refurbished telescope and allowing the determination of sizes, energy fluxes and albedos. There are also indications that the surface of Pluto is resolved to the extent that areas of different reflectivity can be discerned, using advanced image restoration techniques. The results of the investigation were presented.

Planetary evolution and the origin of life

12. Earth is the only planet that we know has life. Is it logical therefore that studies of life on Earth have formed the basis for searching for life on other planets. Life formed on Earth very soon after the end of the formation of the planet. Of all the other planets in the solar system Mars is the most interesting as a target for a search for life. There is evidence that Mars had liquid water on its surface at the same time that life formed on the early Earth. From the perspective of planetary environments, liquid water is the essential requirement for life and serves as a surrogate indicator of life. The search

for fossil evidence of past life on Mars, and possible survivors of that past life, is a key object for future Mars exploration.

A numerical simulation of the Martian polar cap breeze

13. A mathematical model for the Martian polar cap breeze was constructed in part from work previously done by others on the terrestrial sea breeze. With this model a numerical simulation corresponding to the Southern Hemisphere winter season was made. The results obtained with the proposed model show that the Martian polar cap breeze is a well-defined system with some similarities to the terrestrial sea breeze. At the time of maximum intensity, the largest values of vertical velocities are about 10 cm/s and occur at heights between 850-1250 m. The largest values of horizontal velocities are about 15 m/s. A "polar cap breeze front" is clearly discernible in the results. The rate of advance of this front is at an average of about 10 km/h.

E. Comparative planetology: surfaces and interiors

Geological processes on the Earth and planets

14. Comparative studies of the Earth's geology with the surfaces of other planets were addressed as an introduction to the other lectures in the session. The lectures convey the major processes which shape the surfaces of the terrestrial planets: volcanism, tectonism, erosion and impact cratering. The influence of planetary parameters on how these processes operate was also discussed. A brief summary of the surface histories of our Moon, the planets Venus, Mercury and Mars, and the satellites of the outer Solar System was presented. The emphasis of the lecture was on using imaging data acquired by spacecraft to study the surfaces of these bodies.

Impact cratering: the impact crater record of South Africa

15. The presentation emphasized the role that impact cratering has played for the formation of planetary bodies, their profound surface modification, the evolution of life on Earth and the current danger for humankind and its civilization. It further pointed out the often significant economic importance of impact structures that could be an asset for developing countries. The mechanics of the cratering process were outlined and criteria for the recognition of such structures were discussed, with the help of examples from Southern Africa.

The Chicxulub impact and the K/T extinction event

16. Earth has experienced six major extinctions in its geological history and the one at the Cretaceous/Tertiary (K/T) boundary was one of the most severe. Over 50 per cent of the species on Earth went extinct at the K/T boundary 65 million years ago. The extinction event has been best explained by an extraterrestrial body, either a comet or asteroid, impacting the Earth. The impact is believed to have taken place in the Yucatan peninsula, Mexico. The Yucatan impact created what is now known as the Chicxulub crater, first identified during a geophysical survey of the region. Recent studies indicate that the crater is about 200-300 km in diameter, which may represent the largest impact in Earth history. Extinction mechanisms resulting from the Chicxulub impact were discussed.

Double-hump velocity distribution in the polar wind

17. The polar wind is an ambipolar plasma outflow from the terrestrial ionosphere at high latitudes. As the ions drift upward along geomagnetic flux tubes, they move from a collision-dominated layer (ion-barosphere) to a collisionless one (ion-exosphere). A transition layer is embedded between these two

regions where the ion characteristics change rapidly from collision-dominated to collisionless features. A Monte Carlo simulation was used to study the steady-state flow of H+ ions through a background of O+ ions. The simulation domain covered the collision-dominated, transition and collisionless regions. The model properly accounted for the divergence of magnetic field lines, the gravitational force, the electrostatic field and H+-O+ collisions. The H+ velocity distribution, f(H+), was found to be very close to Maxwellian at low altitudes (deep in the barosphere). As the ions drifted to higher altitudes, f(H+) formed an upward tail. In the transition layer, the upward tail evolved into a second peak with a kidney-bean shape, and hence, f(H+) developed a double-humped shape. The second peak grew with altitude and eventually became dominant as the ions reached the exosphere. This behaviour is due to the interplay between the electrostatic force and the velocity-dependent Coulomb collisions. Moreover, the H+ heat flux, q(H+), was found to change rapidly with altitude in the transition layer from a positive maximum to a negative minimum. This remarkable feature of q(H+) is closely related to the coincident formation of the double-humped structure of f(H+).

Solar-terrestrial relations and geomagnetic variations

18. Power spectrum analysis was performed on geomagnetic K_p index recorded at Misallat station in addition to three solar activity indices, namely sunspot number, sunspot area and radio flux at 10.7 cm. Common periodicities of solar origin and K_p are as follows: 11.1 years, 2.4 years, 156.8 days and its harmonics at 78.39 days, 122 days, 100 days, 73.2 days and 64 days. The strong 122 days periodicity has been confirmed. In order to study the effect of latitude and longitude variations on geomagnetic oscillations, periodicities were found for Santa Cruz which is of the same latitude as Misallat and Odessa, which is of similar longitude to Misallat. Common peaks in the three stations are: 32.7, 21.9, 12.9, 11.6, 10.6 and 5 days. Hourly periodicities have also been carried out.

Improving the crescent visibility limits due to factors causing decrease in the sky twilight brightness

19. The measured sky twilight brightness of a site is believed to be connected with main factors such as geographical latitude, elevation of the site above sea level, the season of observations and aerosol pollution. These factors may decrease the sky twilight brightness and thus improve the crescent visibility limits. The effect of these factors on the visibility conditions to see the new Moon were investigated. The results show that the visibility conditions have improved at sites situated at higher northern geographical latitudes and higher elevation above see level. The conditions to see the new Moon is better in winter than in the summer. Aerosol pollution has a great effect on the visibility of the new Moon at Sun's depression 5°, while for Sun's depression greater than 5° aerosol pollution has a small effect.

Variation of evening zenith sky twilight brightness and colour at Abu-Simbel

20. Photoelectric zenith sky twilight brightness measurements have been carried out at the Abu-Simbel site during the first quarter of 1980, using blue, yellow and red filters. The results were reduced to deduce for the site the variation of the zenith sky twilight brightness in absolute units with Sun's depression. The colour indices variation (B-V) and (B-R) with Sun's depression were then deduced from these results. Comparison was carried out between the present result and that deduced at Helwan and Daraw.

F. The Sun

The GALLEX solar neutrino experiment at the Gran Sasso underground laboratory

21. GALLEX is a radiochemical experiment to monitor the solar neutrino flux. It is located in the Gran Sasso Underground Laboratory in Italy. The target consists of 30.3 tons of Ga as $GaCl_3$ in hydrochloric acid solution. The threshold of ^{71}Ga for electron neutrino capture is 233 keV, low enough to also observe pp neutrinos, which have a maximum energy of 420 keV. The $p+p \Rightarrow d+e^{+}+\nu_e$ reaction is at the origin of the main energy producing nuclear reaction chain during hydrogen burning in the Sun. Since May 1991 the GALLEX collaboration performed 30 solar runs and 19 quasi blank runs (runs with typically 1 day exposure). The combined result of all solar runs is [79 ± 10 (stat) ± 6 (syst)] SNU (1σ)(1 SNU = 10^{-36} neutrino captures/targetatom,sec). The blank runs are consistent with zero contributions from unknown sources. This result is short of the standard solar model prediction of (128 ± 7) SNU for gallium, but proves experimentally the hydrogen burning inside the Sun (74 SNU expected from pp and pep neutrinos). The deficit of more energetic neutrinos (^{8}B, ^{7}Be) already observed in other experiments (Homestake, Kamiokande) was also confirmed. A possible explanation of the results of all running solar neutrino experiments is that neutrinos are not massless. Consequently they could change between different lepton flavours, either oscillatory in vacuum or according to the Mikheyev-Smirnov-Wolfenstein effect in matter. Up to now it is an open question, whether introducing a neutrino mass is the right answer for the solar neutrino problem or whether refinements of the solar model will solve the puzzle.

Solar nuclear energy generation and the chlorine solar neutrino experiment

22. The study of solar neutrinos may provide important insights into the physics of the central region of the Sun. Four solar neutrino experiments have confirmed the solar neutrino problem but do not clearly indicate whether solar physics, nuclear physics or neutrino physics have to be improved to solve it. Nonlinear relations among the different neutrino fluxes are imposed by two coupled systems of differential equations governing the internal structure and time evolution of the Sun. This study assumed that the results of the four neutrino experiments are correct and are concerned not with the discrepancy between the average rate and the predicted rate, but with a possible time dependence of the argon production rate as revealed in the Homestake experiment over a period of 20 years. Based on the subtlety of the solar neutrino problem, reviewed qualitatively, it was concluded that the physical laws employed for understanding the internal solar structure and conjecture that the interlink between specific nuclear reactions of the PPIII-branch of the proton-proton chain may allow the high-energy solar neutrino flux to vary over time.

The determination of the internal structure of the Sun by the density distribution

23. This paper examined a number of analytic models which can describe the gravitationally stabilized fusion reactor of the Sun. An analytical multiparameter model was shown to reproduce various structure parameters such as density, mass, pressure and temperature throughout the solar core, which have been obtained by solving numerically the system of solar structure differential equations. For simplicity, numerical and analytical results were discussed in detail for a two-parameter model.

Spotless events as precursor of solar and geomagnetic activities

24. Using the compiled sunspot data during the last 2.5 centuries the frequency distributions of spotless events of different duration across the 11 year cycles 1-19 was investigated. It seems that the spotless events occur in the form of a pattern of strong and weak peaks. Two spotless events have been found, the first has a moderate strength and is located at the 11 year cycle No. 6, while the second one is

relatively weak and exists at the 14th cycle. These depressions of solar activity may arise from the superposition of solar cycles. Various effects of these events on the amplitude and shape of the 11 year cycle have been examined. It was found that the shape of the 11 year cycle strongly depends on the number and length of spotless events in it. The longer and more frequent the spotless periods at a given cycle, the smaller the magnitude of its amplitude. Empirical formulas relating the frequency distribution of spotless events with parameters characterizing sunspot cycles have been deduced. The possibility of using averaged values of such events as precursor for predicting the maximum amplitude and time of rise of the 11 year cycle has also been studied. The results obtained indicate that the number of spotless events in the preceding minimum of a given cycle is well correlated with the maximum amplitude and time of rise of this cycle. The deduced formulas may be further used in the prediction of geomagnetic disturbances. Nearly all versions of the precursor technique correlate the number and length of geomagnetic disturbances with the maximum amplitude of the solar cycle.

High energetic solar proton flares on the declining phase of solar cycle 22

25. The year 1991 was part of the declining phase of the solar cycle 22, during which high energetic flares were produced by active regions NOAA/USAF 6555 in March and by NOAA/USAF 6659 in June. The associated solar proton events affected the Earth environment and their proton fluxes measured by GOES spacecraft. On 22 March 1991 at UT 22 hours 41 minutes an eruptive flare X9/3B was released, associated with ten flare 36000 flux units and proton flux 43000 particle flux units with energies > 10 MeV. Also X12/IF ten flare with strong type II and IV radio bursts was released at UT 15 hour 20 minute of 2 June 1991. The flare occurred beyond the east limb, a spectacular spray with material was visible out to 0.5 solar radii, bright surges and loops were also reported. This flare was the largest since the X15 flare of October 1989. The evaluation of solar flare activity during the second half of March and the first half of June 1991 was followed by applying two independent methods for high energetic solar flares prediction on the flares of March and June 1991. The results indicate two reliable methods, for high energetic solar flare forecasting. All the data used in this study were received from the National Oceanographic and Atmospheric Administration (NOAA), Boulder, Colorado, United States of America.

Seasonal variations of diffuse solar radiation at Ilorin, Nigeria

26. Hourly diffuse solar irradiance H_d falling on a horizontal surface at Ilorin (8° 32'N, 4°46'E), Nigeria, was measured for a period of 15 months commencing February 1993. The diffuse radiation data, after necessary correction for shadow band effect, have been analysed to obtain the diurnal, monthly and annual variations of H_d. Also obtained were the diurnal monthly and annual variations of hourly values of H and H_d/H, where H is the corresponding hourly global irradiance measured separately by another instrument at the same location and time as H.

G. Cosmology

History of astronomy from antiquity to modern times

27. Science is a way of learning about things within and around us. As a science, astronomy is the scientific method to learn about and interpret the Universe. Throughout history man has pondered the meaning of the celestial display. This talk summarized the history of astronomy from antiquity (ancient Egypt, Greece and Babylon) to modern times, also emphasizing astro-archeology was summarized. Most of the early theories of antiquity shared a common property - they assumed that in some way the Earth was special and that what happened in the sky had no relevance to phenomena on Earth. After the decline of the Greek/Roman civilization (in Athens and Alexandria), astronomy flourished and advanced in the Islamic civilization, where the near-perfect transition to the European Renaissance (birth of

modern astronomy) took place. The shift in astronomers' emphasis from classical mechanics (in the European Renaissance) to modern astrophysics (in modern times) was also discussed. Today it is known how the stars, like humans, live and die and that the Universe is expanding. Finally, a look into the future, after the Hubble Space Telescope, was presented

The problem of motion in AP-spaces

28. The problem of motion in spaces admitting absolute parallelism was studied by deriving general path equations. The obtained equations contain one free parameter. For some values of this parameter, the equivalence principle is violated. Equations for geodesics and null geodesics emerge as special cases of the new equations. Some physical and astrophysical applications were given.

Cosmological application of the new general relativity

29. The field equations of the New General Relativity (NGR), constructed by Hayashi and Shirafuji (1979), have been applied to two geometric structures, given by Robertson (1932), in the domain of cosmology. In the first application a family of models, involving two of the parameters characterizing the field equations of NGR, was obtained. In the second application the models obtained were found to involve one parameter only. The cosmological parameters in both applications were calculated and some cosmological problems were discussed in comparison with the corresponding results of other field theories.

Stability of cosmological models

30. The stability problem in cosmology was studied using the equations of geodesic deviation. General conditions for stability were obtained. The method was applied to a number of cosmological models, resulting from different field theories. The results were compared with those obtained from FRW-models.

Cosmology after COBE

31. The COBE mission of NASA has had a major impact on the development of cosmology. The detection of anisotropies by the Differential Microwave Radiometers on board the COBE satellite has proved the gravitational collapse model for structure formation and has provided a unique data set to study the nature of primordial density fluctuations. The detection of structure in the microwave sky by COBE has been confirmed by the Tenerife experiment, and by the FIRS balloon experiment of Princeton, Massachusetts Institute of Technology and Goddard Spaceflight Centre, Maryland. A review of the new results of the analysis of the data of COBE using independent statistical techniques was presented and their implications for cosmological models was discussed. In particular, the topological analysis of the cosmic background maps of COBE and the estimation of the angular power spectrum were used to place important restrictions on the shape of the spectrum of primordial matter density fluctuations.

Surface distortion caused by tides in the galactic binary system

32. Analytic expressions of the equi-potential surface and the distorted potential by tidal effects for the binary galactic system has been derived, using perturbation methods, impulsive approximation as function of masses and the separated distances between two components. The comparison between the numerical solution and the observed one was given.

The implications of intrinsic luminosity evolution on the value of the density parameter and the evolution of radio sizes of radio galaxies and quasars

33. A form of luminosity evolution was assumed and its implications on the value of the density parameter (Ω) and the variation of radio sizes of radio galaxies and quasars with cosmological epoch was investigated. The model yields a value of $\Omega < 0.8$ consistent with an open Universe but higher than the upper limit set by observations. It was also shown that the observed angular diameter-redshift (O-Z) relation for quasars can be interpreted in terms of the assumed luminosity evolution with little or no linear size evolution required. Conversely, strong linear size evolution is required to understand the O-Z relation for radio galaxies. This therefore implies that there is an intrinsic difference in the size distribution of radio galaxies and quasars.

Star counts in the young open cluster Trumpler 37

34. Star counts in young cluster Trumpler 37 were presented. They were based on extensive plate photometry of 1387 stars, brighter than V=15 in a 1.5° field surrounding the young open cluster Trumpler 37. The analysis of cluster centre, density, luminosity function and mass function were investigated.

H. Ground-based and space-based astronomical observations

Microwave radiation from young solar type stars observed at VLA in Socorro

35. Four very young G0 dwarf stars (see table) were observed with the Very Large Array in its C configuration for a total of 29 hours spread over 10 days during June, July and August 1993.

Very young G0 dwarf stars

Star HD	Rotation Period (days)	Rotational Velocity (km/sec)	Separation (arcsecs)	Distance (parsecs)	Radio Flux 4.9GHz (milliJansky)	Radio Flux 8.4GHz (milliJansky)
39587	5.13	10.7	0.6 & 0.095	9.6	0.226	0.93
72905	4.7	11.6	single	13.7	0.041	<0.017
115383	3.5	15.6	34.3	12.7	<0.053	<0.055
206860	unknown	>10.2	single	15.4	<0.042	<0.045

In October 1980 Gary and Linsky observed HD 39587 with the VLA in C configuration and reported detecting a flux of 0,60 +/- 0.227 mJy at 6 cms compared to 0.226 mJy reported in this presentation. The detections are convolved with M stars in the stellar system. HD72905 is a single star with its age of 219 million years calculated from rotational velocity relationship agreeing fairly well with an age of 158 million years derived from its membership in the Ursa Majoris cluster. The first detection of 0.041 mJy at 4.9 GHz reported in this presentation and an upper limit of 0.017 mJy at 8.4 GHz are significant, but additional observations at 2 cms and 20 cms are required to help establish the spectral index and clarify whether the radio flux is due to mass loss.

ROSAT observations of nearby galaxies

36. The X-ray observatory ROSAT has now been in orbit for five years. The wealth of information collected during the initial all-sky survey and the subsequent pointed observation phases has enhanced the number of known X-ray objects by more than an order of magnitude, forming a large database for all kinds of statistical studies and detailed analysis of individual sources. The presentation provided a short overview of the ROSAT mission and then concentrated on ROSAT observations of a few nearby galaxies. One of the results from these studies is the demonstration that in and around many of the galaxies hot gas is found tracing ongoing or past starburst activity. New results also show that at least some of the objects display different forms of nuclear activity. The presentation focused on the spiral galaxy M81 where the ROSAT instruments detected in April 1993, for the first time, early X-rays from a bright supernova event and has followed its evolution until now.

Optical counterparts of ROSAT extreme ultraviolet sources

37. The ROSAT satellite conducted the first ever all-sky survey of extreme ultraviolet sources, which has opened up a new window to the Universe. South African astronomers have been actively involved in the identification of optical counterparts to the southern sources and in follow-up studies. This paper reviewed the survey as a whole, the identification programme and the results to date. The nature of the source population and important new results in the area of active chromosphere stars, hot white dwarfs and magnetic cataclysmic variables were also presented. Particular emphasis was placed on the knowledge gained by multi-wavelength observations, involving both ground- and space-based observations.

Annex II

PROGRAMME OF THE WORKSHOP

DATE/TIME	SUBJECT	SPEAKER
27 JUNE 1994		
08:00-09:00	Registration	
	Session - 1: Inauguration and Opening Ceremony	
09:00-09:05	Welcome address by the Minister	H.E. V. K. Gouda Minister of State for Scientific Research, Egypt
09:05-09:20	United Nations address	N. Jasentuliyana (United Nations)
09:20-09:50	Inaugural address	M. Abdul Hady Egypt
09:50-09:55	ESA address	W. Wamsteker (ESA)
09:55-10:00	TPS address	A. Ocampo (TPS)
10:00-10:30	Keynote address: Modern trends in astronomical telescope engineering	F. Merkle (Germany)
10:30-11:00	Break	
	Session - 2: International cooperation in basic space science	
	Chairman: H. J. Haubold (United Nations)	
11:00-11:30	Space science in West Asia	A. K. Bagchi (Oman)
11:30-11:50	Status of space science in Kenya	F. N. Onyango (Kenya)
11:50-12:10	Space science in China (mainland)	W. -R. Hu (China)
12:10-12:30	An astronomical observatory for Central America: A realistic way of strengthening basic space science in developing countries	M. C. Pineda de Carias (Honduras)

12:30-13:45	Lunch	
	Session - 3: Databases and on-line data in astronomy	
	Chairman: S. C. Chakravarty, India	
13:45-14:15	Making archival data (and how to do science with them) (ESA)	W. Wamsteker
14:15-14:45	Utilization of the European Hubble Space Telescope Science Data Archive	R. Albrecht (ESA)
14:45-15:15	The COBE database and how to use it	S. Torres (Colombia)
15:15-15:30	Break	
	Chairman: H. M. Elgammal, Egypt	
15:30-16:15	On the use of COBE results	M. Melek (Egypt)
16:15-16:30	The TOPEX database	A. Salama (USA)
16:30-16:45	HITRAN database	W. A. Abdou (USA)
16:45-17:30	Working Group session	
17:30-18:00	Break	
	Chairman: W. Wamsteker, ESA	
18:00-19:00	Public lecture: Origin of life	C. McKay (USA)

28 JUNE 1994

	Session - 4: Present and future planetary missions	
	Chairman: W. I. Wanas, Egypt	
09:00-09:30	Sun, Earth and sky	K. R. Lang (USA)
09:30-10:15	Design and navigation of space missions	A. Salama (USA)

10:15-10:30	Galileo mission	R. Lopes (USA)
10:30-10:45	Break	
	Chairman: K. -Ch. Leung, USA	
10:45-11:00	The Discovery programme	A. Ocampo (USA)
11:00-11:15	Mars: Future missions	C. P. McKay (USA)
11:15-11:30	Mars Pathfinder	A. Behar (USA)
11:30-11:45	Cassini mission	C. P. McKay (USA)
11:45-12:00	Differential radial velocity spectrometer for extra solar planetary studies	R. Vikramsingh (USA)
12:00-12:30	North-south asymmetry of the daily interplanetary magnetic field spiral	I. Sabbah (Egypt)
12:30-1400	Lunch	

Session - 5: Comparative planetology: Atmospheres and climate

Chairman: E. Budding, New Zealand

14:00-14:30	Observation of Pluto and Charon with the Hubble Space Telescope	R. Albrecht (ESA)
14:30-15:00	Planetary evolution and the origin of life	C. P. McKay (USA)
15:00-15:30	The origin of life on Mars and other planets	W. L. Davis (USA)
15:30-15:45	Break	
	Chairman: B. Warner, South Africa	
15:45-16:15	Planetary-ocean boundary layer	V. M. Canuto (USA)
16:15-16:45	Outgoing spectral radiances: A climate diagnostic	W. A. Abdou (USA)

16:45-17:15	A numerical simulation of the Martian polar cab breeze	W. Fernandez (Costa Rica)
17:15-17:45	The Linke turbidity factor and Angstroem coefficient in the humid climate of Bahrain	W. E. Alnaser (Bahrain)

Chairman: W. Wamsteker, ESA

17:45-22:00 Working Group session

29 JUNE 1994

Session - 6: Comparative planetology : Surface processes

Chairman: J. S. Mikhail, Egypt

09:00-09:30	Space debris	W. Flury (ESA)
09:30-10:00	Geological processes on the Earth and planets	R. Lopes (USA)
10:00-10:30	Impact cratering	W. U. Reimold (South Africa)
10:30-10:45	Break	

Chairman: R. A. Ghobros, Egypt

10:45-11:00	The impact crater record of South Africa	W. U. Reimold (South Africa)
11:00-11:30	The Chicxulub impact and the K/T extinction event	A. Ocampo (USA)
11:30-12:00	Double-hump velocity distribution in the polar wind	A. R. Barakat (USA)
12:00-12:15	Solar-terrestrial relations and geomagnetic variations	S. O. Ogunade (Nigeria)
12:15-12:45	Improving the crescent visibility limits due to factors causing decrease in the sky twilight brightness	J. S. Mikhail (Egypt)
12:45-13:00	Variation of evening zenith sky twilight brightness and colour at Abu-Simbel during spring	S. Nawar (Egypt)
13:00-14:00	Lunch	

Session - 7: The Sun

Chairman: A. Elsharkawy, Egypt

14:00-14:30	The GALLEX solar neutrino experiment at the Gran Sasso underground laboratory	J. Kiko (Germany)
14:30-15:00	Solar nuclear energy generation and the chlorine solar neutrino experiment	H. J. Haubold (United Nations)
15:00-15:30	Solar nuclear reactions	H. Oberhummer (Austria)
15:30-15:45	Break	

Chairman: K. R. Lang, USA

15:45-16:15	The determination of the internal structure of the Sun by the density distribution	A. M. Mathai (India)
16:15-16:45	Spotless events as precursor of solar and geomagnetic activities	A. A. Galal (Egypt)
16:45-17:15	High energetic solar proton flares on the declining phase of solar cycle 22	M.A.M. Shaltout (Egypt)
17:15- 17:40	FeH molecule in umbra spectrum	D. E. Fawzy (Egypt)
17:40-18:00	Seasonal variations of diffuse solar radiation at Ilorin, Nigeria	M. G. Iziomon (Nigeria)
18:00-18:30	Break	
18:30-19:00	Public lecture: History of astronomy from antiquity to modern times (in Arabic)	A. Salama (USA)

Chairmen: V. Canuto, USA and W. Wamsteker, ESA

19:00-22:00	Working Group session	

30 JUNE 1994

Session - 8: Cosmology

Chairman: H. J. Haubold, United Nations

09:00-09:45	The problem of motion in AP-spaces	M. I. Wanas (Egypt)

09:45-10:30	Cosmological application of the new general relativity	G.G.L. Nashed (Egypt)
10:30-10:45	Break	
	Chairman: A. A. Galal, Egypt	
10:45-11:15	Stability of cosmological models	M. A. Bakry (Egypt)
11:15-11:45	Cosmology after COBE	S. Torres (Colombia)
11:45-12:05	Galaxy dynamics with small computers: Some results on tidal interaction	R. Kochhar (India)
12:05-12:25	Surface distortion caused by tides in galactic binary system	M.E.-S. Awad (Egypt)
12:25-12:40	The implications of intrinsic luminosity evolution on the value of the density parameter and the evolution of radio sizes of radio galaxies and quasars	A. A. Ubachukwu (Nigeria)
12:40-13:00	Star counts in the open cluster Trumpler 37	M. Marie (Egypt)
13:00-14:00	Lunch	

Session - 9: Ground-based and space-based astronomical observations

Chairman: S. M. Hassan, Egypt

14:00-14:30	A global network of small astronomical telescopes	E. Budding (New Zealand)
14:30-15:00	Astronomy with small telescopes	B. Warner (South Africa)
15:00-15:20	The Mauritius radiotelescope	N. Issur (Mauritius)
15:20-15:40	Microwave radiation from young solar type stars observed at VLA in Socorro	R. Vikramsingh (USA)
15:40-16:00	Break	
	Chairman: J. Kiko, Germany	
16:00-16:30	Ginga and ASCA: X-ray astronomy	F. Makino (Japan)

16:30-17:00	ROSAT observations of nearby galaxies	H. -U. Zimmermann (Germany)
17:00-17:30	Optical counterparts of ROSAT extreme ultraviolet sources	D.A.H. Buckley (South Africa)
17:30-18:00	TAUVEX-UV space telescope on board of SRG	E. M. Leibowitz (Israel)
18:00-19:00	Break	

Chairman: W. Wamsteker, ESA

19:00-22:00 Working Group session

1 JULY 1994

Session - 10: Conclusions

Chairmen: H. J. Haubold (United Nations)
A. Ocampo, (TPS)
M. Y. Tawadros (Egypt)
W. Wamsteker (ESA)

09:00-10:45 Working Group session (continued)

10:45-11:00 Break

11:00-12:15 Closing session

Chairmen: M. M. El-Halwagi, Egypt and N. Jasentuliyana, United Nations

(1) Report by Chairmen of the Working Group sessions

(2) Adoption of the report

(3) Closing remarks

Annex III

FOLLOW-UP PROJECTS OF THE UNITED NATIONS/EUROPEAN SPACE AGENCY WORKSHOPS ON BASIC SPACE SCIENCE

First United Nations/European Space Agency Workshop held in India, 1991, for the benefit of Asia and the Pacific (A/A.C.105/489)

Astronomical research telescope

An important topic at the 1991 Workshop on Basic Space Science held in India was an initiative of the Government of Japan to support the establishment of national astronomical observatories in developing countries through the provision of a moderate-sized astronomical research telescope or planetarium. In the past few years Singapore received a Mitaka-kokhi 40 centimetre reflector for its science centre of public education and Malaysia started operating a Minolta Planetarium at the space science education centre. Through the Japanese Cultural Grant Aid Programme, Thailand was able to install a Goto 45 centimetre reflector at the Department of Physics of the Chulalongkorn University, Bangkok, and the Bosscha Observatory, Lembang, Indonesia, is using its Goto 45 centimetre reflector for astronomical research. As a result of this Workshop, Sri Lanka also applied to receive a 45 centimetre astronomical telescope through this Programme. In 1994, the Government of Japan approved this application.

Moderate-sized optical telescopes set-up at appropriate locations on Earth have contributed significantly to astronomical research. The 45 centimetre reflecting telescope from Goto is equipped with a photoelectric photometer, a spectrograph and a photographic camera. Although the telescope was designed primarily for photometric observational studies of variable stars, it also allows for the observation of comets and asteroids. This telescope also offers users the possibility of studying interstellar, interplanetary and atmospheric dust. A network of telescopes of this type regional or worldwide could form an even more powerful astronomical tool. Moreover, it could foster international cooperation in astronomical research over a certain region or, as in the case of the "spacewatch" programme, worldwide. This is one of the major objectives of the United Nations/European Space Agency series of Workshops on Basic Space Science to promote international cooperation, particularly involving developing countries.

Second United Nations/European Space Agency Workshop held in Costa Rica and Colombia, 1992, for the benefit of Latin America and the Caribbean (A/A.C.105/530)

Computer for electronic communication needs

In addition to the scientific programme of the workshop, a vital element of this activity is the working group sessions which provide participants with a forum in which to make observations and recommendations for developing basic space science in all aspects through regional and international cooperation, and to promote basic space science where it has not yet been fully developed. The participants in the Workshop, from both industrialized and developing countries, called for the support of Governments and international organizations to provide computer equipment to universities and research institutes in developing countries where they are most urgently needed. The rapid pace of change in basic space science and technology makes the free and efficient flow of ideas and information of prime importance to facilitate participation in basic space science. It also calls for the establishment of local electronic communication at or above the level of E-mail networks. To this end, the European Space Agency donated 30 personal computer systems for use by universities and research institutes in Cuba, Ghana, Honduras, Nigeria, Peru and Sri Lanka. In 1993/1994 these computer systems were

transferred to the institutions through the respective Permanent Missions of these countries to the United Nations.

Third United Nations/European Space Agency Workshop held in Nigeria, 1993, for the benefit of Africa (A/AC.105/560/Add.1)

Inter-African astronomical observatory

During the Workshop, a proposal for an Inter-African Astronomical Observatory and Science Park on the Gamsberg in Namibia caught the attention of Workshop participants and received the full support of the United Nations. Because of its unique geographic location, Southern Africa can make an immense contribution to astronomy. Certain time-critical phenomena and 24-hour coverage can be obtained only through observatories in all continents (excluding Antarctica) south of the equator. The Gamsberg has been identified as one of the most suitable sites for an observatory in Southern Africa. It is a table-mountain 120 kilometres south-west of Windhoek above the Namib desert at an altitude of 2,350 metres above sea level. It experiences a large number of cloudless nights, a dark sky, excellent atmospheric transparency and low humidity. Comparative test measurements have demonstrated that the above qualities are just as good as those of well-known astronomical sites in Chile. The mountain top is owned by the Max-Planck-Society of Germany and a small astronomical station was established there in the 1970s.

Besides astronomy, the mountain is of considerable interest to other scientific disciplines such as cosmic ray physics, atmospheric research and meteorology, biology and geology. The huge plateau of about 250 hectares offers enough space for various independent installations. The Max-Planck-Institute for Astronomy in Heidelberg, Germany, is trying to initiate the development of a new scientific centre on the Gamsberg. This can only be achieved however, with international support and collaboration. South Africa has expressed an interest in operating the astronomical observatory on behalf of the international community. The ideal solution would be an Inter-African Science Park. The Government of Namibia as well as the recently founded Windhoek University are very much in favour of this project. If provided, this facility could become an important focus in the development of basic space science in African countries. If the facility is established with a viable infrastructure, it is possible that the facility would be attractive to northern hemisphere countries, especially those wishing to establish facilities in the southern hemisphere. The project document for the establishment of a large astronomical telescope in Southern Africa was finalized in 1994 and is currently available for further consideration.

Fourth United Nations/European Space Agency Workshop held in Egypt, 1994, for the benefit of Western Asia (A/AC.105/580)

Kottamia telescope

The Kotamia Observatory, housing a 74 inch reflecting telescope, is located in the north eastern Egyptian desert, 80 kilometres from Helwan, Egypt, on the Cairo Suez road. Because the Kottamia Observatory telescope facility could supply major experimental capabilities for basic space science in the region, its importance cannot be underestimated. Hence, to insure the importance of this telescope facility (the largest in the Western Asia region), further development would be needed. Mindful of this, participants in this Workshop noted with great satisfaction that there was a willingness to cooperate in this effort and further stressed that a collaborative effort to bring about the modernization of the Kottamia Observatory represented one of the most important collaborative efforts in Western Asia. The participants also recommended that, as a matter of priority, this should be done urgently. It was also the intention of the Government of Egypt to open the Kottamia Observatory to all scientists from the region in order to allow access to very important experimental opportunities for basic space science.

The plans of scientists from other countries, both in Western Asia and Africa to share in the further development of the Kottamia Observatory will greatly contribute to the future development of basic space science in the region and will enhance significantly the opportunities for cooperation among basic space scientists in the region, particularly for those engaged in the study of astronomy.

Bibliography

General

Batten, A. H. Astronomy in the Third World. Journal of the Royal Astronomical Society of Canada 88:3:163-168, 1994.

New instruments shed light on astronomy's future. Science 264:348-349, 1994.

Radioastronomers hope for world observatory. Nature 371:5, 1994.

Salam, A. Ideals and realities; selected essays of Abdus Salam, C.H. Lai, ed., 2. ed. Singapore, World Scientific Publishing Company, 1987. 379 p.

Sharing astronomical costs. Nature 339:574, 1989.

World institute for astronomy. Nature 344:188, 1990.

First workshop

American Institute of Physics. Basic space science; proceedings of the first United Nations/European Space Agency workshop on basic space science. New York, 1992. (American Institute of Physics Conference Proceedings Series, No. 245)

Gehrels, T. Possibilities for astrophysics in Sri Lanka. In Fundamental studies and the future of science. C. Wickramasinghe, ed. Cardiff, University College Cardiff Press, 1984. p. 377-385.

Indian Space Research Organization. Report of the first workshop on basic space science. Space India 2:2-15, 1991.

The new telescope at the Bosscha Observatory. By B. Hidayat and others. In Evolution of stars and galactic structure; proceedings of the three-year cooperation in astronomy between Indonesia and Japan. K. Isida and B. Hidayat, eds. Tokyo, National Astronomical Observatory, 1992. 9 p.

United Nations Committee on the Peaceful Uses of Outer Space. Report on the first United Nations/European Space Agency workshop on basic space science, held at Bangalore, India, 30 April-3 May 1991. (A/AC.105/489)

Wickramasinghe, N. C. Setting up of an astronomical observatory in Sri Lanka; proposal including cost implications for approval by the Government of Sri Lanka. 1993. 7 p.
Paper prepared at the University of Wales College of Cardiff.

Second workshop

Basic space science; proceedings of the second United Nations/European Space Agency Workshop on Basic Space Science (Colombia). Astrophysics and Space Sciences 63:1-2, April 1994.

Basic space science; proceedings of the second United Nations/European Space Agency workshop on basic space sciences (Costa Rica). Earth, Moon, and Planets 63:1-2, November 1993.

International Centre for Theoretical Physics. Report on the second workshop on basic space science (Cost Rica/Colombia). News from ICTP 64/65, November/December 1992.

United Nations Committee on the Peaceful Uses of Outer Space. Report on the second United Nations/European Space Agency workshop on basic space science, held at San José, Costa Rica and Santa Fe de Bogotá, Colombia, 2-13 November 1992 (A/AC.105/530)

Third workshop

American Institute of Physics. Basic space science; proceedings of the third United Nations/European Space Agency workshop on basic space science. New York, 1994. (American Institute of Physics Conference Proceedings Series, No. 320)

Committee on Space Research. Report on the third workshop on basic space science. COSPAR Information Bulletin 129:21-22, April 1994.

Stobie, R. S., I. S. Glass and D.A.H. Buckley: Southern African Large Telescope; a proposal for funding. Johannesburg South African Astronomical Observatory, 1993.

United Nations Committee on the Peaceful Uses of Outer Space. Report on the third United Nations/European Space Agency workshop on basic space science, held at Lagos, Nigeria, 18-22 October 1993. (A/AC.105/560/Add.1)

Note: The recommendations and observations that emanated from the four United Nations/European Space Agency workshops on basic space science, held in India (1991), Costa Rica and Colombia (1992), Nigeria (1993) and Egypt (1994) are available on the World Wide Web (WWW) through file transfer protocol (ftp) at the electronic address FTP://ECF.HQ.ESO.ORG/PUB/UN/UN-HOMEPAGE.HTML.